Detection of Cosmic Shear from STIS Parallel Archive Data: Data Analysis

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1 Introduction

In June 1997, parallel observations using the Space Telescope Imaging Spectrograph (STIS) on the HST started to be taken in substantial numbers along many different lines-of-sight. We are using the imaging data to investigate the distortion of background galaxies by the gravitational field of the large scale matter distribution, also known as Cosmic Shear. This effect was recently detected from the ground (Van Waerbeke et al. 2000, Bacon et al. 2000, Kaiser et al. 2000, Maoli et al. 2001, Wittman et al. 2000 and Van Waerbeke et al. 2001) and from space (Rhodes et al. 2001). The typical object sizes that have to be measured are in the order of $< 0.5''$. Therefore, STIS is perfectly suited to such studies, thanks to its resolution and sensitivity. Also, due to intrinsic cosmic variance, this project requires many observations of separate fields, each containing tens of small faint background galaxies, for which the parallel observations are adequate. This poster presents the data and the catalog production that leads to the cosmic shear result presented in poster "First Cosmic Shear results from STIS parallel program archive data" (Hämmerle et al. in this conference). The data is publicly available also at http://www.stecf.org/projects/shear.

2 Data Reduction

STIS CCD images provide a good deepth, excellent resolution and adequate sampling of the telescope PSF. The detector has a pixel size of $0.05''$ and a field of view of $51''$ and is sensitive to wavelengths from 2500 to 11000 Å. making it more efficient than WFPC2 for Cosmic Shear studies.

The data used is a subset of the available STIS Parallel Survey Data between June 1997 and October 1998 which satifies the following conditions:

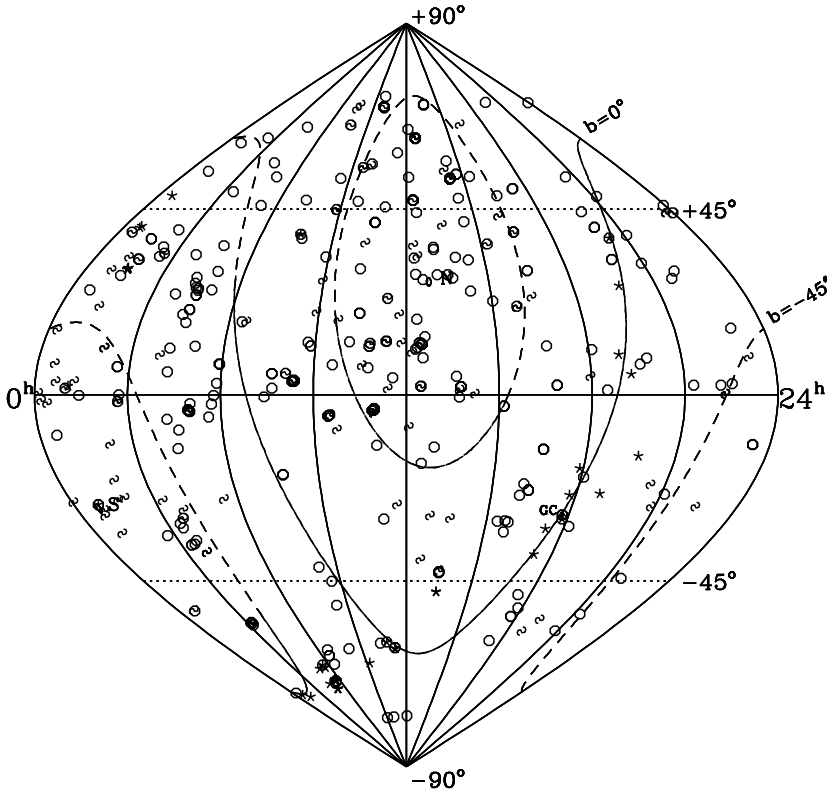

Figure 1: Galactic coordinates positions of the 498 co-added fields. Stars, swirls and circles represent stellar fields, galaxy fields and non-classified fields.

- Taken in the CLEAR filter mode (unfiltered CCD)
- CR-SPLIT mode
- Unbinned
- Associated "jitter ball" rms value smaller than 1/10 of a STIS pixel

Individual exposures were then associated and co-added using the procedure described in Pirzkal et al. (2001). This procedure removes cosmic rays, hot-pixels and uses a cross-correlation technique combined with drizzling to achieve an accuracy of 1/10 of a pixel in the co-addition. This procedure was tested through simulations of STIS data, confirming that the shape and flux of individual objects was preserved.

498 co-added images were produced from which we identified 122 galaxy fields (with more than 10 extended objects) and 55 star fields (with more than 100 point like objects). The images on the right show you a few exemples of galaxy and star fields.

3 Data properties

The properties of the 122 galaxy fields were studied more carefully to characterize the objects observed:

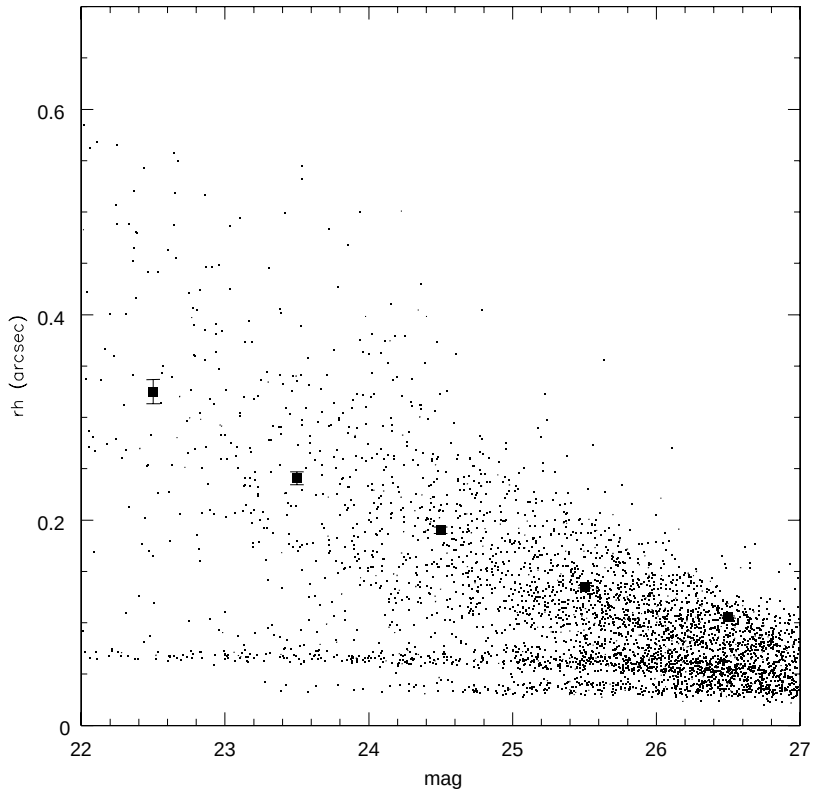

Figure 2: Measured half-light radius (rh) of objects in co-added STIS images. The horizontal distribution of points at rh between 0.05" and 0.08" is caused by stars and other unresolved objects. The average sizes of galaxies per magnitude bin are indicated by square dot marks (counting only rh>0.08"). Errors bars represent the 1s level in the error of the mean.

- The number counts of galaxies are consistent with previous estimates (Gardner & Satyapal 2000).
- The optimal integration time is between 2000 and 2500 seconds, leading to an average number of 29 galaxies to be detected at 3 s level.
- The limiting magnitude reached, for a 5 pixel detection at 3 s level is M_{AB}=28.5 in a 3600s exposure.
- The average size of galaxies with magnitudes ranging from 22 to 26 vary for $0.3''$ to $0.1''$ and are also consistent with previous observations.

While the redshift distribution of these galaxies is currently unknown, it is going to be determined using photometric redshift with VLT images that are presently being obtained.

4 Catalog production

Catalogs are produced using Sextractor (Bertin & Arnouts 1996) and IMCAT (Kaiser, Squires and Broadhurst 1995) following the subsequent procedure:

- Sextractor detects sources and calculates magnitudes
- IMCAT detects sources and measures sizes and shapes (e.g.: rh, e1 and e2)
- The final catalog is the result of the merging of the Sextractor and IMCAT catalogs according to their coordinates. Only objects which have an unique detection within a radius of $0.125''$ in both catalogs are kept (using the Sextractor coordinates as reference).

5 For the Future...

More STIS parallel data is actually being collected through a cycle 9 GO parallel program especifically dedicated to Cosmic Shear (Prop. 8562+9248, P.I.: P. Schneider). Since the end of September 2000 and up to date, about 400 associations have been already produced and will allow us to increase the accuracy and significance of the Cosmic Shear signal detected atscales less than the arcminute.

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